

**What is claimed is:**

1. A surface finishing apparatus for surface finishing a workpiece, comprising:

a workpiece supporting mechanism supporting a workpiece having a target shaped periphery to be surface finished;

5 a surface finish tool adapted to be in abutting contact with the target shaped periphery of the workpiece;

a pressure applying mechanism operative to apply a pressure force to the surface finish tool to cause the surface finish tool to be held in pressured contact with the target shaped periphery of the workpiece, with the pressure  
10 force exhibiting a distribution pattern depending upon an axial direction of the workpiece; and

a drive mechanism rotating the workpiece about the axial direction during operation of the pressure applying mechanism to allow the surface finish tool to surface finish the target shaped periphery of the workpiece into a given  
15 geometrical profile, while exhibiting the distribution pattern of the pressure force of the surface finish tool.

2. The surface finishing apparatus according to claim 1, further comprising a tool shifting mechanism cyclically moving at least one of the workpiece and the surface finish tool in a given stroke such that a working position of the  
20 surface finish tool is cyclically shifted in the given stroke with respect to the target shaped periphery of the workpiece to allow the same to be surface finished in the given geometrical profile.

3. The surface finishing apparatus according to claim 2, wherein:

the surface finish tool includes a lapping film including a thin-walled base  
25 member having an entire surface provided with abrasive material with an abrasive surface of the thin-walled base member and adapted to face the target shaped periphery to be lapped; and

the pressure applying mechanism includes a plurality of shoes disposed on a rear side of the lapping film so as to allow the abrasive surface of the lapping  
30 film to be held in contact with the target shaped periphery to be lapped.

4. The surface finishing apparatus according to claim 3, wherein the pressure applying mechanism includes a tool holder that operatively holds the plurality of shoes on the rear side of the lapping film in different contact areas in a partially overlapping relationship at a central region of the target shaped periphery and in non-overlapping relationship in both terminal regions of the target shaped periphery to be lapped.
5. The surface finishing apparatus according to claim 4, wherein the plurality of shoes are held in opposing offset positions with respect to a center of the target shaped periphery to be lapped.
6. The surface finishing apparatus according to claim 5, wherein the plurality of shoes include even number of shoes with the same width and the even number of shoes are alternately offset at different sides with respect to the center of the target shaped periphery to be lapped.
7. The surface finishing apparatus according to claim 5, wherein an amount of offset displacement between the plurality of shoes falls in a value ranging from 3 to 12 % of the given width of the target shaped periphery to be lapped.
8. The surface finishing apparatus according to claim 5, wherein:  
the tool shifting mechanism includes an oscillating mechanism oscillating at least one of the workpiece and the lapping film in the axial direction of the workpiece; and  
offset displacement between the plurality of shoes is set to be less than an oscillation stroke provided by the oscillating mechanism.
9. The surface finishing apparatus according to claim 3, wherein the workpiece includes a crankshaft having a journal portion or a pin portion each having the target shaped periphery on both ends of which fillet portions are formed.
10. The surface finishing apparatus according to claim 3, wherein the lapping film includes the thin-walled base member that is non-extensible and deformable.
11. The surface finishing apparatus according to claim 3, wherein the tool

holder further includes a shoe pressure force adjusting unit operative to adjust a shoe pressure force to be applied to the plurality of shoes.

12. The surface finishing apparatus according to claim 11, wherein:

the tool shifting mechanism includes an oscillating mechanism oscillating  
5 at least one of the workpiece and the lapping film with respect to one another in axial direction of the workpiece ; and further comprising:

a detecting unit detecting a relative oscillating position of the workpiece with respect to the lapping film during oscillating movement performed by the oscillating mechanism to be indicative of a current relative oscillating  
10 movement of the workpiece; and

a controller variably controlling the pressure force adjusting unit to vary the shoe pressure force in response to the current relative oscillating movement of the workpiece such that the lapping film is held in contact with the target shaped periphery of the workpiece to lap the target shaped periphery into the  
15 given geometrical profile.

13. The surface finishing apparatus according to claim 12, wherein the controller controls operation of the pressure adjusting unit such that the pressure force occurring when the oscillating position of the workpiece assumes both terminal portions of an oscillating stroke of the workpiece  
20 during the oscillating movement thereof becomes greater than that occurring when the oscillating position of the workpiece assumes a central position on the oscillating stroke of the workpiece during the oscillating movement thereof, whereby the given geometrical profile is formed into at least one of a flat shape and a mid-convex shape.

25 14. The surface finishing apparatus according to claim 12, wherein the controller controls operation of the pressure adjusting unit such that the pressure force occurring when the oscillating position of the workpiece assumes both terminal portions of an oscillating stroke of the workpiece during the oscillating movement thereof becomes smaller than that occurring  
30 when the oscillating position of the workpiece assumes a central position on

the oscillating stroke of the workpiece during the oscillating movement thereof, whereby the given geometrical profile is formed into a mid-concave shape.

15. The surface finishing apparatus according to claim 13, wherein the  
5 controller controls the operation of the pressure adjusting unit such that a change rate, between the pressure force occurring when the oscillating position of the workpiece assumes the both terminal portions of the oscillating stroke of the workpiece during the oscillating movement thereof and the pressure force occurring when the oscillating position of the  
10 workpiece assumes the central position on the oscillating stroke of the workpiece during the oscillating movement thereof, required for forming the geometrical profile into the mid-convex shape, is set to be greater than that required for forming the geometrical profile into the flat shape.

16. The surface finishing apparatus according to claim 3, wherein the pressure  
15 applying mechanism includes first and second presser arms pivotally supported to be moved in an open position and a closing position, first and second shoe cases slidably carried by the first and second presser arms and disposed on the rear side of the lapping film held in contact with the target shaped periphery of workpiece, and first and second pressure force adjusting  
20 units cooperating with the first and second shoe cases, respectively, to apply adjustable shoe pressure forces to the first and second shoes, respectively.

17. The surface finishing apparatus according to claim 16, wherein the first and second pressure force adjusting units includes first and second lift adjustment elements operatively connected to the first and second shoe cases  
25 through first and second presser rods, respectively, and first and second actuators connected to the first and second lift adjustment elements, respectively, to vary angular working positions of the first and second lift adjustment elements with respect to the first and second presser rods, respectively, for thereby varying the shoe pressure forces to be applied to the  
30 first and second shoes, respectively.

18. The surface finishing apparatus according to claim 1, wherein:

the workpiece has the target shaped periphery with the geometrical profile, lapped in a mid-concave shape;

a tool holder is connected to the pressure applying mechanism and includes  
5 a tool support; and

the surface finish tool includes a burnishing roller supported by the tool support in pressured contact with the target shaped periphery of the workpiece for thereby burnishing terminal convex portions of the target shaped periphery in given surface roughness.

10 19. The surface finishing apparatus according to claim 18, wherein the burnishing roller is operative to flatten sharp edges on both the terminal convex portions of the target shaped periphery.

20. The surface finishing apparatus according to claim 19, wherein the target shaped periphery of the workpiece includes a journal portion or a pin portion  
15 of a crankshaft formed with fillet portions on both ends of the target shaped periphery.

21. The surface finishing apparatus according to claim 1, wherein:

the workpiece has the target shaped periphery with the geometrical profile, formed in a cylindrical configuration;

20 the surface finish tool includes a cylindrical burnishing roller supported by the pressure applying mechanism in alignment with the axial direction of the workpiece;

the pressure applying mechanism includes a tool holder supporting the cylindrical burnishing roller; and

25 a rocking mechanism is supported by the pressure applying mechanism and rocking the burnishing roller through the tool holder with respect to the axial direction of the workpiece, the target shaped periphery being burnished in a centrally ridged profile that has a central portion larger in diameter than both ends of the central portion.

30 22. The surface finishing apparatus according to claim 21, wherein:

the tool holder is pivotally supported on a pivot shaft and has one end operatively connected to the rocking mechanism to be pivotally moved for causing the burnishing roller to rock with respect to the target shaped periphery of the workpiece; and

- 5 the pivot shaft is pressured against the target shaped periphery of the workpiece by the pressure applying mechanism during rocking operation of the rocking mechanism.

23. The surface finishing apparatus according to claim 22, wherein:

- the rocking mechanism includes a pair of pinch members operatively  
10 connected to the one end of the tool holder, a pair of support members supporting the pair of pinch members, respectively, and a rocking source supported by the pressure applying mechanism and connected to the support members to rock the tool holder; and

- an amount of rocking movement is controlled to enable an rocking angle of  
15 the support members to be controlled.

24. The surface finishing apparatus according to claim 23, wherein the rocking source includes a piston/cylinder mechanism.

25. The surface finishing apparatus according to claim 21, wherein the workpiece includes a crankshaft having a journal portion or a pin portion  
20 each having the target shaped periphery on both ends of which fillet portions are formed.

26. A surface finishing apparatus for surface finishing a workpiece, comprising:

- workpiece supporting means for supporting a workpiece having a target  
25 shaped periphery to be surface finished;

a surface finish tool adapted to be in abutting contact with the target shaped periphery of the workpiece;

- pressure applying means for applying a pressure force to the surface finish tool to cause the surface finish tool to be held in pressured contact with the  
30 target shaped periphery of the workpiece, with the pressure force exhibiting a

distribution pattern depending upon an axial direction of the workpiece; and

rotating means for rotating the workpiece about the axial direction during operation of the pressure applying means to allow the surface finish tool to surface finish the target shaped periphery of the workpiece into a given geometrical profile, while exhibiting the distribution pattern of the pressure force of the surface finish tool.

27. A method of surface finishing a workpiece , the method comprising:

supporting a workpiece having a target shaped periphery to be surface finished;

holding a surface finish tool in abutting contact with the target shaped periphery of the workpiece;

applying a pressure force to the surface finish tool to cause the surface finish tool to be held in pressured contact with the target shaped periphery of the workpiece, with the pressure force exhibiting a distribution pattern depending upon an axial direction of the workpiece; and

rotating the workpiece about the axial direction to allow the surface finish tool to surface finish the target shaped periphery of the workpiece into a given geometrical profile, while exhibiting the distribution pattern of the pressure force of the surface finish tool.